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SPECIFICATION

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

RUNWAY VISUAL RANGE SENSOR FOR CATEGORY IIIb

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1. SCOPE AND CLASSIFICATION

1.1 Scope.- This specification sets forth the requirements for a Visibility Sensor which will be used for air traffic control by providing an instrumentally derived value of RVR for Category IIIb levels of flight operations. The current RVR 500 system provides RVR from 600 ft to 6000 ft. This specification describes equipment necessary to extend the visibility range from 600 ft to 100 ft. The sensor to be provided shall input to the current RVR remote displays subsystem (Type FA9472). The sensor equipment will be mounted for unattended, continuous and unprotected outdoor operation at airports.

1.2 Classification.- Two types of visibility sensors are covered by this specification.

1.2.1 Transmissometers.- Visibility sensors that are designed to measure and give continuous indication of the transmissivity of the atmosphere over a selected line of sight, and are known as transmissometers.

1.2.2 Scattering Coefficient Meters.- Visibility sensors that are designed to measure scattered light within a limited volume of space known as scattering coefficient meters.

1.3 Applicable Definitions

1.3.1 Runway Visual Range (RVR).- The term RVR, as used herein, shall denote a value of runway visual range, normally determined by instruments located alongside and about 14 feet higher than the centerline of a runway, that approximates the horizontal distance a pilot can see down the runway from the approach end or at the rollout end. It is based on the sighting of either high intensity runway centerline lights or on the visual contrast of runway surface markings whichever yields the greater visual range.

1.3.1.1 RVR Equations.- Visibility sensors do not actually measure runway visual range. Instead, they measure either the fraction of luminous flux(t_b) that remains in a beam of light, after it has traveled a distance (b), or alternatively, the fraction of luminous flux scattered out of the beam expressed in terms of extinction coefficient (σ). Standardized equations, based on human observations, are then used to calculate the visual range of lights or contrast markings. These equations include:

RVR of Lights

$$E_T = \frac{IT^R}{R^2}, \quad E_T = \frac{It_b^{R/b}}{R^2}, \quad \text{where, } T = t_b^{1/b}$$

Alternatively

$$E_T = \frac{Ie^{-\sigma R}}{R^2} \qquad \text{(RVR of Lights)}$$

RVR of Contrast Markings

$$\epsilon = T^R$$

alternatively **(RVR of Contrast Markings)**

$$\epsilon = e^{-\sigma R}$$

Where E_t = Visual threshold of illumination
I = Intensity of runway lights
T = Transmissivity of the atmosphere
t_b = Transmittance of the atmosphere over distance b, (Transmissometer baseline).
R = Visual Range
b = Transmissometer baseline
ϵ = Visual contrast threshold ratio
σ = Extinction coefficient

1.3.2 Category of operation.- All-weather instrument approach operations are divided into categories corresponding to different standards of instrumentation in the aircraft and on the ground. For each category, there is a minimum value of specified runway visual range below which operations are not permitted. The following table identifies the categories and LOWEST minima associated with each:

Category	Visibility (RVR)
Nonprecision	2,400 feet
Category I	1,800 feet
Category II	1,200 feet
Category IIIa	700 feet
Category IIIb	150 feet
Category IIIc	0 feet

The term Category IIIb, as used herein, shall denote the category of flight operations corresponding to landing and take-off runway visual range values within the limits of 150 feet to 700 feet.

1.3.3 Regular Transmittance.- The term regular transmittance, as used herein, shall denote the radiant or luminous unscattered flux which remains in a beam after traversing an optical path of a given length in the atmosphere (Dimensionless; length of path has to be stated). Also called "transmission coefficient".

1.3.4. Transmissivity.- The term transmissivity, as used herein, shall denote the regular transmittance of light through unit distance of atmosphere (Dimensionless).

1.3.5 Extinction Coefficient.- The term extinction coefficient, as used herein, shall denote the attenuation of radiant or luminous flux due to scattering and absorption in passing through unit distance of the atmosphere. (In visibility computations this is expressed as the proportion of luminous flux lost per unit distance).

1.3.6 Scattering Coefficient Meter.- The term scattering coefficient meter, as used herein, shall denote an instrument that determines the scattering coefficient of flux scattered from a light beam.

1.3.7 Calibration Verification is an automatic and manual means of verifying sensor calibration.

1.3.8 Failure Monitoring.- The term failure monitoring, as used herein denotes a means of determining if a sensor failed and the failure is indicated in the equipment room.

2. APPLICABLE DOCUMENTS

2.1 General.- The following specifications and standards, of the issues specified form a part of this specification and are applicable to the extent specified herein.

2.1.1 FAA Specifications, Standards and Orders

FAA-D-2494/1a	Technical Instruction Book Manuscripts: Electronics Equipment, Requirements for: Part I - Preparation of Manuscript.
FAA-D-2494/2a	Instruction Book Manuscripts; Electronic, Electrical, and Mechanical Equipment, Requirements For: Part II - Preparation of Reproducible (Camera-Ready) copy and original artwork.
FAA-G-2100c	Electronic Equipment, General Requirements.
FAA-STD-012a	Paint Systems for Equipment.
FAA-STD-013a	Quality Control System Requirements
FAA-STD-021	Configuration Management
FAA Order AF6000.10	Airway Facilities Service Maintenance Program, dated 6/3/82
FAA Order 6560.8A	Maintenance of Runway Visual Range (RVR) Equipment.

TI 6560.4	Instruction Book, Vol 4, Runway Visual Range (RVR 500 series) Signal Data Convertor RVR 500/2 Type FA 9472/2.

2.1.2 Military Specifications, Standards and Handbooks

MIL-E-17555G	Electronic and Electrical Equipment, Accessories, and Repair Parts; Packaging and Packing of.
MIL-STD-454	Standard General Requirements for Electronic Equipment.
MIL-STD-461B	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference.
MIL-STD-470	Maintainability Program Requirements for Systems and Equipments.
MIL-STD-471	Maintainability Demonstration
MIL-STD-483	Configuration Management Practices for Systems, Equipment, Munitions, and Computer Programs.
MIL-STD-785B	Reliability Program for Systems and Equipment Development and Production.
MIL-STD-1521	Technical Reviews and Audits for Systems, Equipment, and Computer Programs.
MIL-STD-810C	Environmental Test Methods

2.1.3 Other Publications

"Transient Susceptibility Standard"
National Weather Service (NWS)
May 1978
IEEE Lightning Protection Standard

The following document is referenced for information only.

"Visual Range: Concepts, Instrumental Determination, and Aviation Applications", No. AD-A041 098 C.A. Douglas and R.L. Booker, February 1977.

(Copies of this specification and other applicable FAA specifications, standards and drawings may be obtained from the Contracting Officer in the Federal Aviation Administration Office issuing the invitations for bids or request for proposals.

Requests should fully identify material desired, i.e., specification, standard, amendment, and drawing numbers and dates. Requests should cite the invitation for bids, request for proposals, or the contract involved or other use to be made of the requested material).

(Single copies of applicable and military specifications, standards and drawings may be obtained by ordering through the Naval Publications and forms Center (NPFC), Philadelphia, which is the Department of Defense Single Stock Print (DOD-SSP) and distribution center for unclassified specifications and standards. Documents may be ordered by writing: Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120; or calling: 215-697-3321, Monday through Friday, from 8 a.m. to 4:30 p.m. (Philadelphia time.)

(Information on obtaining copies of Transient Susceptibility Standard may be obtained from Department of Commerce, National Weather Service, Sterling, Virginia 22170).

(Copies of "Visual Range:....." may be obtained from the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22161.)

2.2 Precedence.- When conflicts exist between the requirements of the contract and this specification, the contract shall take precedence. When conflicts exist between the requirements of this specification and its referenced documents, this specification shall take precedence.

3. REQUIREMENTS

3.1 GENERAL.- The RVR sensor specified herein shall provide a measured value which can be used by the RVR system to provide a continuous indication that is the equivalent of the transmissivity derived from the regular transmittance of a uniform atmosphere over a 40 foot baseline. This information will be used as an input to existing RVR/500 systems comprised of a Type FA-9471 Transmissometer and a Type FA-9472, RVR Remote Display Subsystem (Type FA-9472/1 Signal Data Converter - Main Frame, a Type FA-9472/2 Signal Data Converter (SDC), a Type FA-9472/3 Ambient Light Sensor, a Type FA-9472/4 Remote Display Programmer, a Type FA-9472/5 Runway Light Setting Box, a Type FA-9471/1 RVR Graphic Recorder and a Type FA-8998/9 Support Tower). The existing RVR system operates with a single baseline (250 feet) and provides RVR measurements within the range of 600 to 6000 feet. With the addition of the specified sensor this RVR range is extended to 100 feet. A simplified block diagram of the extended RVR system is shown in Figure 1.

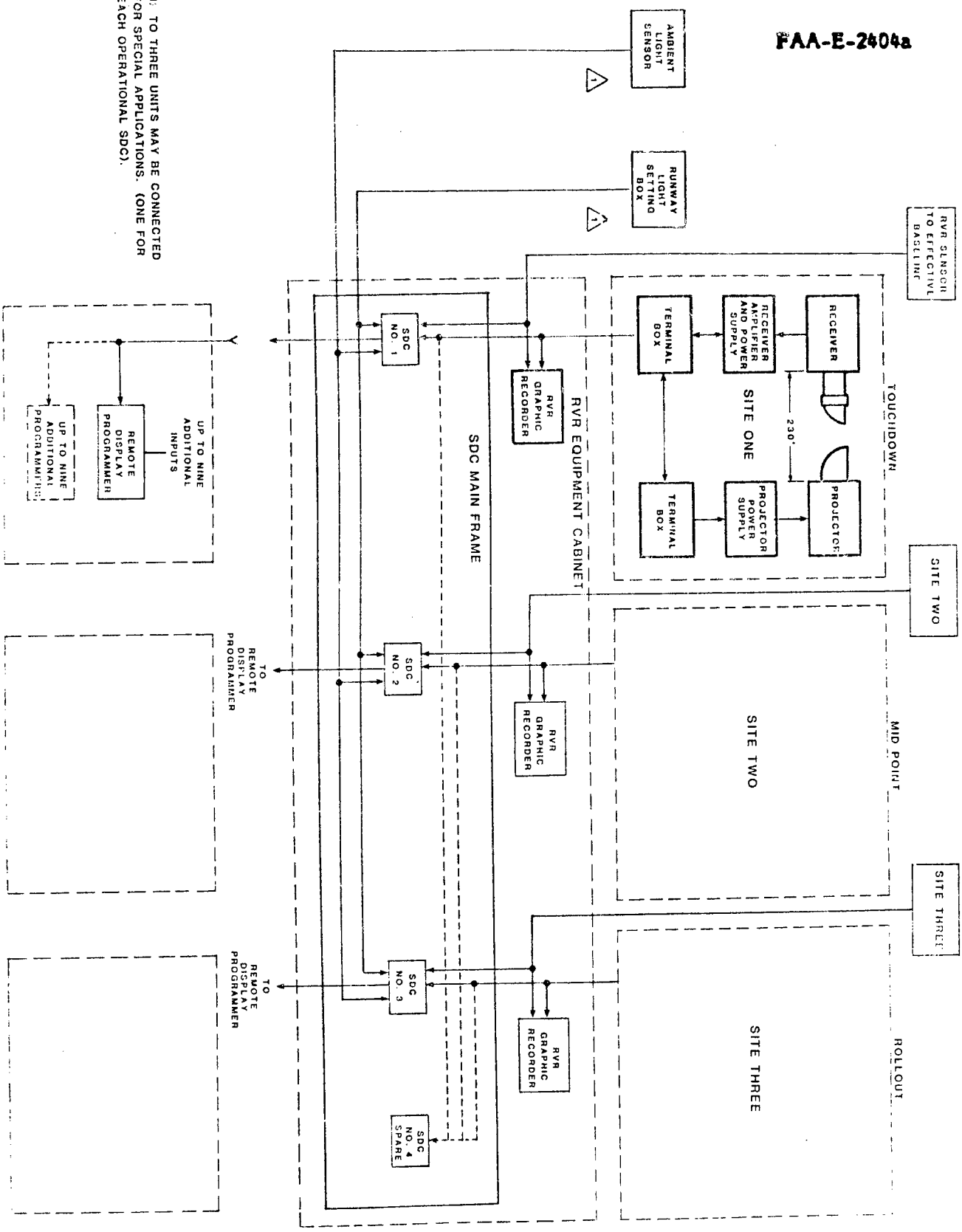


FIGURE 1. Extended RVR System Simplified Block Diagram

3.1.1 Equipment to be Furnished by the Contractor.- It shall be the option of the contractor to furnish a visibility sensor to any one of the following RVR sensor configurations:

3.1.1.1 Partial Transmissometer.- The partial transmissometer, RVR sensor, consisting of the following major components:

Transmissometer Receiver	One Required
Associated Electronics	One Required
Terminal Box	One Required
Support Structure	One Required
Special Test Equip & Calibration Device	One Required

3.1.1.2 Complete Transmissometer.- The complete transmissometer RVR sensor, consisting of the following major components:

Transmissometer Projector	One Required
Transmsissometer Receiver	One Required
Associated Electronics	One Required
Terminal Box(s)	One or Two Required
Support Structure(s)	One or Two Required
Special Test Equipment & Calibration Device	One Required

3.1.1.3 Scattering Coefficient Meter.- The scattering coefficient meter type RVR sensor, consisting of the following major components:

Projector	One Required
Receiver	One Required
Associated Electronics	One Required
Support Structure	One Required
Special Test Equipment & Calibration Device	One Required

3.1.2 Government Responsibilities.- The Government shall provide a complete RVR/500 (Type FA 9472) system for in plant contractor tests. Also, the Government shall be responsible for the installation of all production units, following the acceptance of a prototype sensor.

3.1.2.1 Special Tools.- The sensor projector or receiver is an LRU. The replacement time shall be 0.5 hour or less. If any special tools or equipment are required to perform the functions of paragraph 3.1 it will be contractors responsibility to supply them. In addition a list of said tools and equipment shall be provided to the contracting officer coincidental with the submission of the provisioning parts list.

3.2 CHARACTERISTICS

3.2.1 Performance Characteristics.- All three configurations of visibility sensors as specified, shall give a continuous indication of the transmissivity corresponding to the following performance requirements.

3.2.1.1 Sensor Accuracy.- The visibility sensor shall have an accuracy of ± 10 percent of the RVR value (root-mean square equivalent). By "root-mean-square equivalent" is meant the equivalent 90-percent confidence level of a normal error distribution having a standard deviation of 10 percent. The 90 percent confidence level corresponds to 1.65 times the standard deviation or a 16.5 percent error. Thus the calculated RVR value must agree with a standard measurement to within 16.5 percent accuracy at least 90 percent of the time. It must also agree to within a factor of two 99 percent the time. The sensor drift in a 90 day interval shall not cause an RVR system error of more than 10 percent for the most sensitive reporting value.

3.2.1.2 Visibility Sensor Output:

3.2.1.2.1 Visibility Sensor Minimum Pulse Rate.- For conditions which result from absence of signal and background radiation, the sensor/output shall be a pulse rate of no greater than 1 pulse in 90 seconds.

3.2.1.2.2 Visibility Sensor Transmittance Pulse Rate Precision.- The sensor output pulse rate precision shall be in accordance with TI 6560.4.

3.2.1.2.3 Time Constant.- The inherent time constant of the sensor (before signal conversion to pulses) shall not exceed 5 seconds. (time to reach 63% of final output for any "step" change in visibility).

3.2.2 Physical Characteristics.- The equipment shall reflect the optimum in simplicity, reliability, maintainability, energy efficiency, weight and ease of installation that is consistent with maximum safety to personnel while installing, operating, and maintaining the equipment.

3.2.3 Environmental Service Conditions.- Each visibility sensor furnished by the contractor shall be installed at airports for continuous and unattended operation outdoors. The sensor shall operate in any and all combination of environments and environmental conditions described below.

3.2.3.1 Natural Environment.- The natural environmental service conditions are those designated as environment III in accordance with FAA-G-2100C, Paragraph 3.2.15. Those requirements shall be tested in environmental test program.

3.2.3.1.1 Rainfall.- Exposure to continuous rainfall at the rate of 2±0.5 inches per hour for a period of 2 hours.

3.2.3.1.2 Snow.- Accumulation of 12 inches, at the rate of 2 inches per hour.

3.2.3.1.3 Hail.- Exposure to hail occurring at a moderate rate.

3.2.3.1.4 Salt Fog.- Exposure to salt-sea atmosphere.

3.2.3.1.5 Sand, Dust, Pollution.- Exposure to sand, dust, and pollution particles.

3.2.3.1.6 Fungus.- Exposure to fungus growth.

3.2.3.1.7 Insects.- Exposure to insects.

3.2.3.1.8 Birds and Small Ground Animals.- Exposure to birds and small ground animals.

3.2.3.2 Induced Environment. - The induced environmental service conditions are those as specified herein.

3.2.3.2.1 Electromagnetic.- The visibility sensors shall be designed to operate within the electromagnetic interference and susceptibility limits specified in MIL STD 461B, part 4 as defined below:

CE-03	Conducted emissions, power and interconnecting leads, Fig. 4-3 & 4-4, Curve #1
CE-07	Conducted emissions, power leads, spikes, time domain.
CS-01	Conducted susceptibility by, power leads, 30Hz to 50 HKz.
CS-02	Conducted susceptibility by, power leads, 0.05 to 400MHz.
CS-06	Conducted susceptibility by, spikes, power leads, spike #2 (Figure).
RE-O2	Radiation emission electric field 14KHz to 10GHz Fig. 4-13.
RS-02	Radiation susceptibility by, magnetic induction fields, spikes and power frequencies, spike #2.
RS-03	Radiated susceptibility, electric fields, 14HKz-10 GHz, Air Force levels.

3.2.3.2.2 Acoustical Interference.- Exposure to acoustic emissions from nearby aircraft traffic (ground and air, fixed and rotary wing).

3.2.3.2.3 Visible Light Interference - Exposure to ambient visible light of varying intensity and duration.

3.2.3.3 Mechanical.- The equipment shall withstand and operate without damage or degradation of performance when subject to exposure to vibration and shock induced by airport conditions such as jet blast, and prop wash.

3.2.3.4 Electrical.- The equipment shall be powered from a single-phase two wire source, with the voltage and frequency characteristics below.

3.2.3.4.1 Voltage.- The equipment shall be powered from all voltages within the limits of 102 to 138 volts.

3.2.3.4.2 Frequency.- The equipment shall be powered from all frequencies within the limits of 57 hertz to 63 hertz.

3.2.3.5 Power and Signal Line Transients.- Exposure to power and signal line transients as designated in Transient Susceptibility standard, National Weather Service (NWS), May 1978, Subparagraph 2.1.1

3.2.3.6 Lightning.- Exposure to lightning induced transients in accordance with subparagraph 2.2.2 of Transient Susceptibility Standard, NWS, May 1978.

3.3 Functional and Design Requirements

3.3.1 Functional Requirements

3.3.1.1 Partial Transmissometer.- The partial transmissometer RVR sensor specified herein is a transmissometer without a light source (projector) but is so constructed and mounted that it can be used with an existing RVR transmissometer projector to form a dual-baseline. The receiver with separate or integral electronics (amplifiers, power supplies, interface component, etc.) shall be mounted in a weather proof enclosure placed on a supporting structure and must maximize both receivers within the field of illumination of 95% of the existing transmissometer projector. It shall be capable of collecting the light from the projector and generating a signal pulse rate that is directly proportional to the amount of light reaching a photoelectric detector within the receiver. The receiver shall be equipped with an adjustable attenuating device that permits adjustment of the amount of light that reaches the photoelectric detector and thus controls the pulse rate. Calibration of the sensor shall be obtained corresponding to zero, intermediate and 100 percent atmospheric transmittance, with reference to a separate calibration device. Intermediate values shall be obtained by means of calibrated filters and shall also be used to check the linearity of sensor response.

3.3.1.2 Complete Transmissometer.- The complete transmissometer RVR sensor differs from the partial transmissometer in that it shall be equipped with a projector and projector electronics (power supply, meter and control electronics). It may use the present projector support structure if the installation does not interfere with the operation and maintenance of the RVR-500 system.

3.3.1.3 Scattering Coefficient Meter.- The scattering coefficient meter RVR sensor, specified herein may be one of three general types: a) backscatter meters, b) sidescatter meters and c) forward scatter meters. They differ from each other by the type of scattered light that is collected at the receiver from the atmospheric sample volume, i.e., back, side or forward directed. The major components of these instruments shall be mounted in a single unit of weather proof construction and placed on a supporting structure. An interface component shall be provided that will convert the measured extinction coefficient. Calibration of this sensor shall be obtained at three points corresponding to zero, intermediate and 100 percent points on a calibration device.

3.3.2 Design Requirements.- The equipment delivered shall meet the functional requirements of the visibility sensors as specified herein.

3.3.2.1 General.

3.3.2.1.1 Accessibility.- Accessibility shall be in accordance with specification FAA-G-2100C, Subparagraph 3.3.1.1.

3.3.2.1.2 Electron Tubes.- Electron tubes shall not be used in this equipment.

3.3.2.1.3 Corona and Electrical Breakdown.- Shall be in accordance with MIL-STD-454, Requirement 45.

3.3.2.1.4 Grounding, Bonding, Shielding, and Transient Protection.- Shall be in accordance with FAA-G-2100C, Subparagraph 3.3.1.5.

3.3.2.1.5 Human Engineering.- Shall be in accordance with MIL-STD-454, Requirement 62.

3.3.2.1.6 Accoustical Level Limits.- Shall be in accordance with FAA-G-2100C, Subparagraph 3.3.1.7.

3.3.2.1.7 Personnel Safety.- Shall be in accordance with FAA-G-2100C, Subparagraph 3.3.1.8 and all subdivisions therein.

3.3.2.1.8 Thermal Design.- Shall be in accordance with FAA-G-2100C, Subparagraph 3.3.1.9 and all subdivisions therein.

3.3.2.1.9 Electrical.- Shall be in accordance with FAA-G-2100C, Subparagraph 3.3.2 and all subdivisions therein.

3.3.2.1.10 Mechanical.- Shall be in accordance with FAA-G-2100C, Subparagraph 3.3.3 and all subdivisions therein.

3.3.2.1.11 Operation Under the Service Conditions.- Shall be in accordance with FAA-G-2100C, Subparagraphs 3.3.4.1 and 3.3.4.2.

3.3.2.1.12 Lightning Protection.- RVR equipment shall be protected against damage or operational upset due to lightning induced surges on the incoming AC powerlines or data communications lines. It will be the contractor's responsibility to identify and provide the protecting devices for their equipment on both ends of all land lines. The devise shall be in accordance with IEEE Lightning Protection Standard.

3.3.2.2 Parts and Material, General.

3.3.2.2.1 Application Use and Orientation of Parts and Materials. -Shall be in accordance with FAA-G-2100C, Subparagraph 3.4.1.

3.3.2.2.2 Certification of Military Specification Parts and Materials. - Shall be in accordance with FAA-G-2100C, Subparagraph 3.4.2.

3.3.2.2.3 Specific Parts.- Shall be in accordance with FAA-G-2100C, Subparagraph 3.4.3.

3.3.2.2.4 Standard and Non Standard Parts and Materials.- Shall be in accordance with FAA-G-2100C, Subparagraph 3.4.5.

3.3.2.2.5 Submission of Requests for Approval of Standard and Non Standard Parts and Materials.- Shall be accordance with FAA-G-2100C, Subparagraph 3.4.6.

3.3.2.2.6 Contractor Responsibility.- Shall be accordance with FAA-G-2100C, Subparagraph 3.4.7.

3.3.2.2.7 Mounting of Small Parts.- Shall be accordance with FAA-G-2100C, Subparagraph 3.4.8.

3.3.2.2.8 Derating Policy and Design Tolerance Values.- Shall be in accordance with FAA-G-2100C, Subparagraph 3.4.9, 3.4.9.1, and 3.9.2.

3.3.2.2.9 Bonding, Securing, and Fastening Methods.- Shall be in accordance with FAA-G-2100C, Subparagraph 3.4.9, 3.4.9.1, 3.4.9.2.

3.3.2.2.10 Interchangeability.- Shall be in accordance with FAA-G-2100C, subparagraph 3.4.11.

3.3.2.3 Parts.- Application and use of the following parts shall be in accordance with FAA-G-2100C, Paragraph 3.5 and all subdivisions therein.

Batteries	Rivets and Eyelets	Microelectronics	Solderless Wrap
Bearings	Filters, Electrical	Motors	Special Tools
Capacitors	Fuses	O-Rings	Springs
Circuit Breakers	Gaskets	Printed Wiring	Switches
Controls	Gears and Cams	Readout Devices	Terminals
Crystal Units	Glass	Relays	Transformers
Delay Lines	Grommets	Resistors	Tuning Dials
Electrical Connectors	Indicator Lights	Rotary Servos	Waveguides
Fastener Hardware	Meters	Semiconductors	Wiring
	Meter Shunts	Sockets	

3.3.2.4 Materials.- Application and use of the following materials shall be in accordance with FAA-G-2100C, Paragraph 3.6 and all subdivisions therein.

Adhesives	Ferrous Alloys	Materials	Rubber
Arc-Resistant Materials	Fibrous Materials	Insulating Materials	Wood
Dissimilar Metals	Flammable Materials	Lubricants	

3.3.2.5 Processes.- Use of the following processes shall be in accordance with FAA-G-2100C, Paragraph 3.7 and all subdivisions therein.

Brazing	Encapsulation	Welding, Structural	Finishes
Casting	Soldering	Welding, Interconnections	

3.3.2.6 Reference Designations.- Shall be in accordance with FAA-G-2100C, Paragraph 3.8.

3.3.2.7 Marking.- Shall be in accordance with FAA-G-2100C, Paragraph 3.9, and all subdivisions therein.

3.3.2.8 Nameplates.- Shall be in accordance with FAA-G-2100C, Paragraph 3.10 and all subdivisions therein.

3.3.2.9 Workmanship.- Shall be in accordance with MIL-STD-454, Requirement 9.

3.4 Visiblity Sensor Interface Requirements.- This paragraph identifies the principal interface requirements between the equipment specified and the system with which it must be compatible.

3.4.1 Description of Existing System.- The existing system includes the following equipment.

a. Three RVR 500/10 Transmissometer Sets (or equal, modified to solid state configuration) located adjacent to the touchdown, midpoint and rollout zones of the instrument runway. These instruments are installed with 250-foot baselines on transmissometer support towers in accordance with established standards. Each touchdown transmissometer includes one RVR 500/7 Graphic Recorder located in an equipment room or weather office accessible to maintenance personnel. The Graphic Recorder is expected to utilize an Esterline Angus Chart Recorder conforming to Tasker Part No. 600665-01.

b. One RVR 500/1 SDC Main Frame installed in an equipment room.

c. Three RVR 500/2 Signal Data converter units. A fourth unit may be available as a standby spare.

d. One RVR 500/3 Ambient Light Sensor.

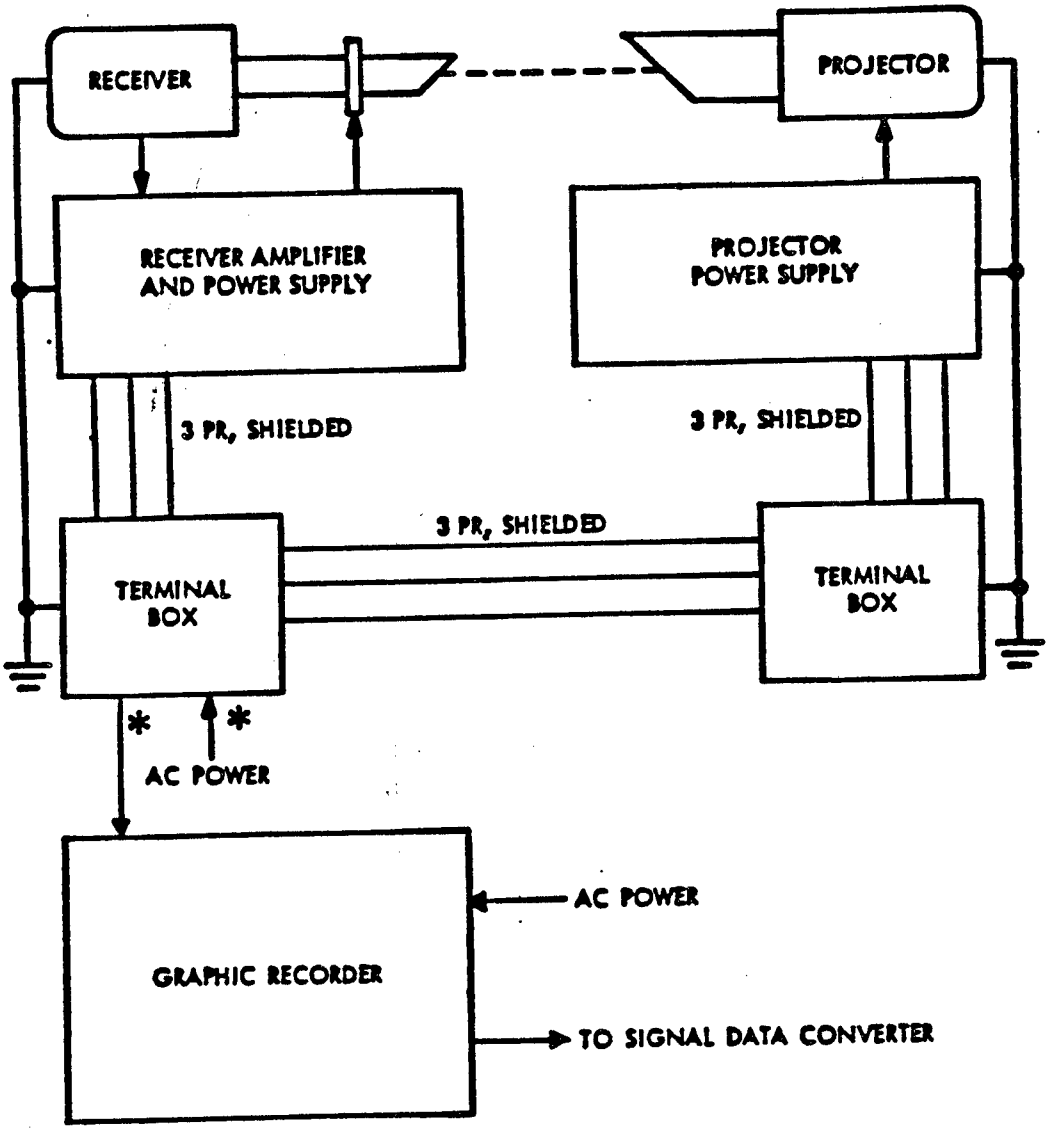
e. One each RVR 500/5 Runway Light Setting Box.

f. One or more RVR 500/4P Remote Display Programmer.

The transmissometer (Figure 2.) may be conveniently divided into three functional areas: Projector System, Receiver System, and Graphic Recorder.

Projector System.- The projector system contains a sealed-reflector lamp operated at a constant intensity, a power supply, a terminal box, and a means of aligning the projector to the receiver. The power supply provides a regulated current for the projector lamp.

Receiver System.- The receiver system contains a telescope with a photo-electric detector and pulse generator, an amplifier and power supply, and a terminal box. The telescope is aligned to collect light from the projector. It excludes most stray light from the background. A photoelectric detector and pulse generator provides an output signal in the form of pulses. The pulse rate is proportional to the light incident in the photoelectric detector. The amount of light reaching the receiver is determined by the transmissivity of the air between the projector and the receiver. Fog, rain, snow, dust and other air contaminants reduce the amount of light reaching the receiver and cause a reduction in the output pulse rate. The receiver amplifier and power supply provides operating voltages for the receiver and amplifier.



* CONNECTION FOR AC POWER AND SIGNAL TO GRAPHIC RECORDER MAY BE MADE AT TERMINAL BOX FOR RECEIVER OR PROJECTOR

Figure 2. Transmissometer Block Diagram

Graphic Recorder.- The graphic recorder is a frequency meter and strip chart recorder that converts the pulse signal to a direct current that is proportional to the pulse rate and hence to the transmittance. The strip chart recorder provides a continuous record of the output of the frequency meter portion.

Transmissometer Supports.- The projector and receiver must be mounted on supports that are rigid enough to maintain the pointing accuracy under the conditions of wind, ice loading, temperature changes, etc. that are encountered near the runway. The supports should locate the line of sight between the projector and receiver so that it is level and approximately 15 feet (4.6 meters) above the elevation of the runway centerline. Two Transmissometer Support Towers Type FA-8998/9 are generally used, with one tower supporting the receiver and receiver amplifier power supply. The second tower supports the projector and projector power supply. To facilitate access to the tower platform while carrying electronic test equipment, a Tower Ladder Modification Kit, Type FA-9473 has beeen added to each tower.

3.4.1.1 Projector Lamp Details.- If the existing projector is used, the following applies. The projector lamp is a GE #120-PAR/64 sealed reflector lamp having a 6-volt, 120-watt, single-coil filament. The parabolic reflector of the lamp produces a beam, measured at 95 percent of peak intensity at 500 feet, of 1 degree vertical and ½ degree horizontal. The peak intensity of the beam is rated at 140,000 candelas. The beam spread at 10 percent of peak intensity is 5 degrees horizontal by 10 degrees vertical. The lamp is operated in a constant current mode. The sensitivity of the receiver permits the lamp to be operated at a voltage and current of about 4 volts and 15 amperes respectively.

3.4.1.2 Receiver Output Pulse and Signal Metering Detail.- The output of the receiver pulse amplifier must be a pulse 25 ± 5 volts with a width of 50 ± 5 microseconds. The output pulse rate is 66.67 $\pm .3$ hertz (4000 pulses per minute) when the transmittance is 100 percent. When the light source is obscured by fog, rain, dust or snow, the pulse rate is reduced and may be only a few pulses per minute. If the receiver lens aperture is entirely blocked, more than a minute may elapse between pulses. The output pulses are AC coupled to the signal line, since the DC level of the line is used for control of the projector power supply. The signal line connects the receiver pulse amplifier to the projector power supply and to the graphic recorder via a twisted pair of wires that can be as long as 5 miles. A transmittance metering circuit in the receiver furnishes both a local reading and a remote reading at the projector power supply, via a second pair of twisted wires. The remote transmittance meter is used to align the projector to the receiver.

3.4.2 Interface Requirements.- Each type of RVR sensor furnished by the contractor shall be in complete accordance with the following interface requirements:

3.4.2.1 Partial Transmissometer.- Since this type of RVR sensor uses the existing transmissometer projector as a light source it must be installed between each existing transmissometer set projector and receiver. The effective baseline (not actual distance) must be 40 feet. The collecting optics of this short baseline (40 feet vs 250 feet for the existing transmissometer set) must be such as to minimize

any light, other than the projected light beam from entering the receiver detection system. This total system must be designed so that both receivers are within 95% of the peak beam intensity at 500 feet. Also, it must provide control/signal pulses and metering in accordance with Subparagraphs 3.4.1.1 and 3.4.1.2.

3.4.2.2 Complete Transmissometer and Scatter Coefficient Meter.- Both of these visibility sensors are stand-alone types and do not depend on the existing system for operation as visibility sensors. However, the sensor must interface electrically to the existing system as follows:

3.4.2.2.1 Sensor Measured Value to Transmissivity Conversion.- The sensor must convert its measured value to a transmissivity value that is the equivalent of the transmissivity derived from the regular transmittance of a uniform atmosphere over a 40 foot baseline as defined in TI 6560.4.

3.4.2.2.2 Transmissivity to Pulse Rate Conversion.- The sensor must convert the transmissivity value into a proportional pulse rate.

3.4.2.2.3 Background Response.- The sensor must respond appropriately when the existing system performs a background check.

3.4.2.2.4 Background Check.- The transmissometer projector places a 30 VDC bias through a 3.3K resistor on the control/signal line. If the processing unit shorts out this bias (by applying a DC ground) the projector lamp is extinguished so that background pulse rate can be measured. The control unit normally measures the background for one minute every hour and subtracts the background count from subsequent one minute signal counts to correct for the background. The projector lamp is extinguished if the bias drops below 8 VDC. The sensor should respond as follows:

When the bias drops below 8 volts the pulse generator should generate a small background pulse rate (1 to 10 pulses/minute) which is adjustable in steps of 1 pulse/min. Since it will be subtracted from the signal rate, it can be used to correct for any zero drift in the pulse generating circuit.

3.5 Equipment Instruction Manuals.- Equipment instruction manuals shall be supplied in accordance with the applicable paragraphs of FAA-D-2494/1A and 2A.

3.6. Reliability and Maintainability Requirements.

3.6.1. Basic Reliability. - The visibility sensor shall have a Mean-Time-Between Failures (MTBF) of 2,000 hours.

3.6.2.2 Preventive Maintenance. The visibility sensor shall require routine preventive maintenance including lens cleaning no more than once every 90 days.

3.6.3 Reliability Program

3.6.3.1 Program Surveillance and Control.- The reliability, program surveillance and control elements shall meet the following specifications:

3.6.3.1.1 Reliability Program Plan.- A reliability program plan shall be prepared in accordance with MIL-STD-785B, Task 101, and submitted as a separate and complete entity within the proposal.

3.6.3.1.2 Monitor/Control of Subcontractors and Suppliers.- Shall be in accordance with MIL-STD-785B, Task 102.

3.6.3.1.3 Program Reviews.- Shall be in accordance with MIL-STD-785B, Task 103.

3.6.3.1.4 Failure Reporting, Analysis, and Corrective Action System (FRACAS). - Shall be in accordance with MIL-STD-785B Task 104.

3.6.3.1.5 Failure Review Board (FRB).- Shall be in accordance with MIL-STD-785B, Task 105.

3.6.3.2 Reliability Design and Evaluation.- The reliability design and evaluation elements shall meet the following specifications:

3.6.3.2.1 Reliability Modeling.- A reliability model for making numerical apportio nments and estimates to evaluate equipment reliability shall be developed in accordance with MIl-STD-785B, Task 201.

3.6.3.2.2 Reliability Allocations.- Shall be in accordance with MIL-STD- 785B, Task 202.

3.6.3.2.3 Reliability Prediction.- An estimate of the basic reliability of the visibility sensor design shall be determined in accordance with MIL-STD-785B, Task 203.

3.6.3.2.4 Parts Program.- Shall be in accordance with MIL-STD-785B Task 207.

3.6.3.3 Reliability Development and Production Testing.- The reliability development and production testing elements shall meet the following specifications.

3.6.3.3.1 Environmental Stress Screening (ESS).- Shall be performed in accordance with MIL-STD-785B, Task 301.

3.6.3.3.2 Reliability Development Program.- The reliability development/growth program shall be in accordance with MIL-STD-785B, Task 302.

3.6.4 Maintainability Program.

3.6.4.1 Maintainability and Repair Philosophies.- Maintainability and Repair Philosophies shall be in accordance with FAA Order AF 6000.10, "Airway Facilities Service Maintenance Program" dated 6/3/82, and the following:

a. The equipment shall be designed and constructed to minimize the skill, experience, and time for a technician to diassemble, assemble, and maintain them.

b. Corrective maintenance shall be a remove-and-replace module unit concept with repair of the replaced item at a maintenance area or separate facility.

c. Preventive (scheduled) maintenance shall not be performed more than once each 90 days.

d. Mean Bench Repair Time (MBRT) - MBRT is the average length of time to repair an LRU. This time includes failed component isolation time, component replacement time, and time required to verify the LRU is operational.

3.6.4.2 Maintainability Program Plan.- A maintainability program plan shall be prepared and submitted in accordance with MIL-STD-470, Pragraph 5.1.

3.6.4.3 Maintainability Analysis.- Shall be in accordance with MIL-STD-470, Paragraph 5.2.

3.6.4.4 Detailed Maintenance Plan.- Shall be prepared in accordance with MIL-STD-470, Paragraph 5.8.

3.6.4.5 Establish Maintainability Design Criteria.- Shall be in accordance with MIL-STD-470, Paragraph 5.4.

3.6.4.6 Maintainability vs. Design Tradeoffs.- Shall be in accordance with MIL-STD-470, Paragraph 5.5.

3.6.4.7 Predict Maintainability Parameter Values.- Shall be in accordance with MIL-STD-470, Paragraph 5.6.

3.6.4.8 Participate in Design Reviews.- Shall be in accordance with MIL- STD-470, Paragraph 5.9.

3.6.4.9 Establish Data Collection, Analysis, and Corrective Action System.- Shall be in accordance with MIL-STD-470, Paragraph 5.10.

3.6.4.10 Demonstrate Achievement of Maintainability Requirements.- Shall be in accordance with MIL-STD-470, Paragraph 5.11.

3.6.4.11 Prepare Maintainability Status Reports.- Shall be in accordance with MIL-STD-470, Paragraph 5.12.

3.6.5 Configuration Management.- A Configuration Management Program shall be established in accordance with MIL-STD-483. A Configuration Management Plan shall be submitted in accordance with FAA-STD-021, Appendix I. Configuration audits shall comply with MIL-STD-483, Appendix XII, and shall be supported in accordance with MIL-STD-1521, Appendix E.

4. QUALITY ASSURANCE PROVISIONS.

4.1 General Requirements.- A quality control program shall be established and maintained in accordance with FAA-STD-013a.

4.1.1 Government Inspections.- All tests and inspections made by the contractor shall be subject to Government inspection. The term "Government inspection", as used in this specification, means that an FAA representative will witness the contractor's testing and inspection, and will carry out such visual and other inspections as deemed necessary to assure compliance with contract requirements. Tests shall be conducted at the Contractor's plant or test facility and at the Contractor's expense. All test facilities instrumentation connection and personnel necessary to conduct the tests required by this specification shall be furnished by the Contractor.

4.2 Classification of Acceptance Tests.- The following classes of tests are required to demonstrate the acceptability.

Environmental tests
Environmental Stress Screening.
Interface Compatibility.
Sensor Accuracy and Stability.
Maintainability Demonstration.
Production Test

4.2.1 Acceptance Test Requirements.- This paragraph contains the test provisions to demonstrate satisfactory compliance with each of the requirements in Paragraph 3 of this specification. The tests will in some cases, be performed with the visibility sensor, prototype unit, interfaced to a government furnished (GFE) RVR/500 system. Also, the tests will be performed inhouse and at an operational airport RVR site, prior to government acceptance.

4.2.1.1 Environmental Test.- Refer to 3.2.3

4.2.1.2 Environmental Stress Screening (ESS).- The purpose of these tests is for the early identification of failures, parts, subassemblies and a complete unit, due to weak parts, workmanship defect and other non-conformance anomalies. During ESS, the sensor shall be cycled through its operational modes in accordance with the test procedures of FAA-G-2100C, Paragraph 4.11 while simultaneously being subjected to the environmental service conditions of Paragraph 3.2.3 and all subdivisions therein.

4.2.1.3 Interface Compatibility.- An interface compatibility test shall be established to demonstrate that the sensor operates in accordance with the requirements of Paragraph 3.4 and all subdivisions therein.

4.2.1.4 Visibility Sensor Accuracy.- The visibility sensor shall have an accuracy of $\pm$ 10 percent (root-mean-square equivalent) of an RVR value.

The test matrix consists of three obstructions to vision by two extinction coefficient ranges. Each box in the matrix must have a number of samples at least equal to ten times the percent weighting and from at least two distinct events, or it will not be included in the analysis. All data collected must be included, but the number of data samples falling outside the 16.5% error levels must be normalized to the total number of samples under given conditions. In order to meet the accuracy test, no more than 10 percent of the data samples weighted over the entire test matrix may

fall outside the 16.5-percent error limit. Also, less than one percent shall show errors larger than a factor of two.

Test Matrix Weighting (Percent)

Extinction Coefficient (km-1)	Fog	Rain	Snow
11-38	30	10	10
38-35	30	10	10

An alternative method of testing a sensor over the extinction coefficient range of 38-350 km^{-1} is to use a single short baseline transmissometer (less than 60-foot-18.4 meters baseline) as a reference. Because no uniformity check would be possible, the 10 and 1 percent accuracy levels above would be relaxed to 20 and 2 percent respectively. A sensor must pass both the 11-38 km^{-1} and 38-350 km^{-1} tests to be acceptable.

4.2.1.5 Maintainability Demonstration Test.- A test to demonstrate the maintainability requirements of this specification for the prototype sensor, shall be performed in accordance with the Test Method 4 of MIL-STD-471.

5. PREPARATION FOR DELIVERY

5.1 General.- Preservation, packaging and marking shall be in accordance with the requirements of MIL-E-17555G.

5.2 Preservation and Packaging.- Each unit, complete with two sets of instruction books, shall be preserved and packaged in accordance with MIL-E-17555G, Subparagraph 3.3.1 Level C, Method IIA.

5.3 Packing.- Packing shall be accordance with MIL-E-17555G Subparagraph 3.4, Level C.

5.4 Marking.- Marking shall be accordance with MIL-E-17555G Subparagraph 3.6.

6. NOTES.

6.1 Intended Use.- The equipment specified herein is intended for use at airports to provide runway visual range data, essential to the safety of departing and arriving aircraft.

6.2 Preproduction Model.- The contract schedule should specify the requirement for a preproduction model for evaluation in accordance with Paragraph 4. of this specification prior to quantity production. Quantity production will be contingent upon approval of the preproduction model.